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SEMIANNUAL STATUS REPORT I.
ON
DYNAMIC BEHAVIOR OF POROUS ELECTRODE SYSTEMS

by

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STATUS REPORT FOR PERIOD 10 AUGUST 1961 TO 28 FEBRUARY 1962

NASA RESEARCH GRANT NsG-150-61

This report covers the progress of the investigation, Dynamic Behavior of Porous Electrode Systems, during the first six months of NASA Research Grant, NsG-150-61. The work is being conducted in the Department of Chemical Engineering, University of California, Berkeley under the direction of Professor Charles W. Tobias. The scope of preliminary investigation undertaken during this period, the direction of future research efforts, facilities utilized, expenditures incurred, and personnel involved are reported herein.

1. Scope of Investigation

In considering porous electrode behavior, both theoretical and experimental investigations are being conducted. The experimental work is being planned to verify assumptions used in the mathematical treatment and to correlate parameters involved in theoretical treatments with available physical data.

(a) Theoretical Treatment

Two basic approaches to the mathematical characterization of porous electrode behavior are being utilized. In the first a one-dimensional macroscopic treatment of an electrode of non-characterized pore geometry is considered. This follows the treatment of Euler and Nonnenmacher (ref. 1) as extended at this laboratory under other sponsorship (ref. 2). Studies are under way to relate the parameters of the mathematical model employed in this approach to determinable characteristics of physical systems.

In the second approach, an analysis is being made of the processes occurring with passage of current in individual pores of exactly defined geometry. Pore configurations selected for study are the fissure of infinite lateral extent and the cylinder. The rigorous mathematical descriptions of these systems have been simplified by certain assumptions including that of concentration independent diffusion coefficients and mobilities, and of local electroneutrality. Thus simplified, the equation systems are being adapted to numerical solution with linear or Tafel overpotential relations as boundary conditions at the interfaces.

(b) Experimental Treatment

Two types of experimental investigations are being prepared. In one, a porous electrode of uncharacterized pore geometry is segmented in the direction of depth into the electrode, and current drawn from each segment measured. This will yield current distribution data for the one-dimensional, macroscopic case. In the other case, an electrode with carefully constructed micropore structure of simple geometry is likewise segmented and operated. From this type of investigation, data corresponding to mathematically analyzed situations, for pore of characterized geometry, can be

obtained. The equipment for both experimental endeavors has been designed and will shortly be fabricated. The extremely small dimensions required for the artificial micropore structure leads to considerable difficulty in construction.

2. Direction of Research Efforts for March-August 1962

In the coming six months the number of cases analyzed by the macroscopic, one-dimensional approach will be extended considerably beyond those treated in ref. 2. The numerical solutions for the case of geometrically characterized pores will be undertaken, utilizing available digital computing machinery (IBM 7090 etc.).

The fabrication of the experimental electrodes, and their associated cells, will be completed and measurements taken using suitable redox systems.

3. Facilities

The College of Chemistry just completed the construction of newly equipped laboratory space in which this project will be conducted. Special apparatus necessary for conducting the above described experiments will be installed following completion of the move from old quarters. Certain instrumentation necessary for the precise current measurements required has been or will be purchased. To date the principal acquisition has been a Kiethly Model 610R Electrometer.

4. Expenditures

The semiannual statement of expenditures is scheduled to be issued by the Business Office of the University on March 15, 1962. The rate of spending was lower over the first six months of this gran than predicted. Responsible factors for this are: Participation of personnel without salary (Mr. Grens), and relocation of laboratory.

5. Personnel

The personnel involved in this research project at the present time consist, in addition to the principal investigator, of one Post Doctoral Fellow (1/2 time), Dr. Rolf H. Müller; two graduate students, Edward A. Grens II and John Bomben (only the latter is supported by funds from this project); and two laboratory assistants, Mr. Beng-Tiong Yo (1/2 time) and Mr. Denes Turcsanyi (1/4 time).

6. References

(1) Euler, J. and Nonnenmacher, W.; Electrochimica Acta 2, 268 (1960).

(2) Newman, J; A Model for the Analysis of Behavior of Porous Electrodes, (Thesis) Report No. 3, Contract No. N123(62738 23531A (USN); December 1961.